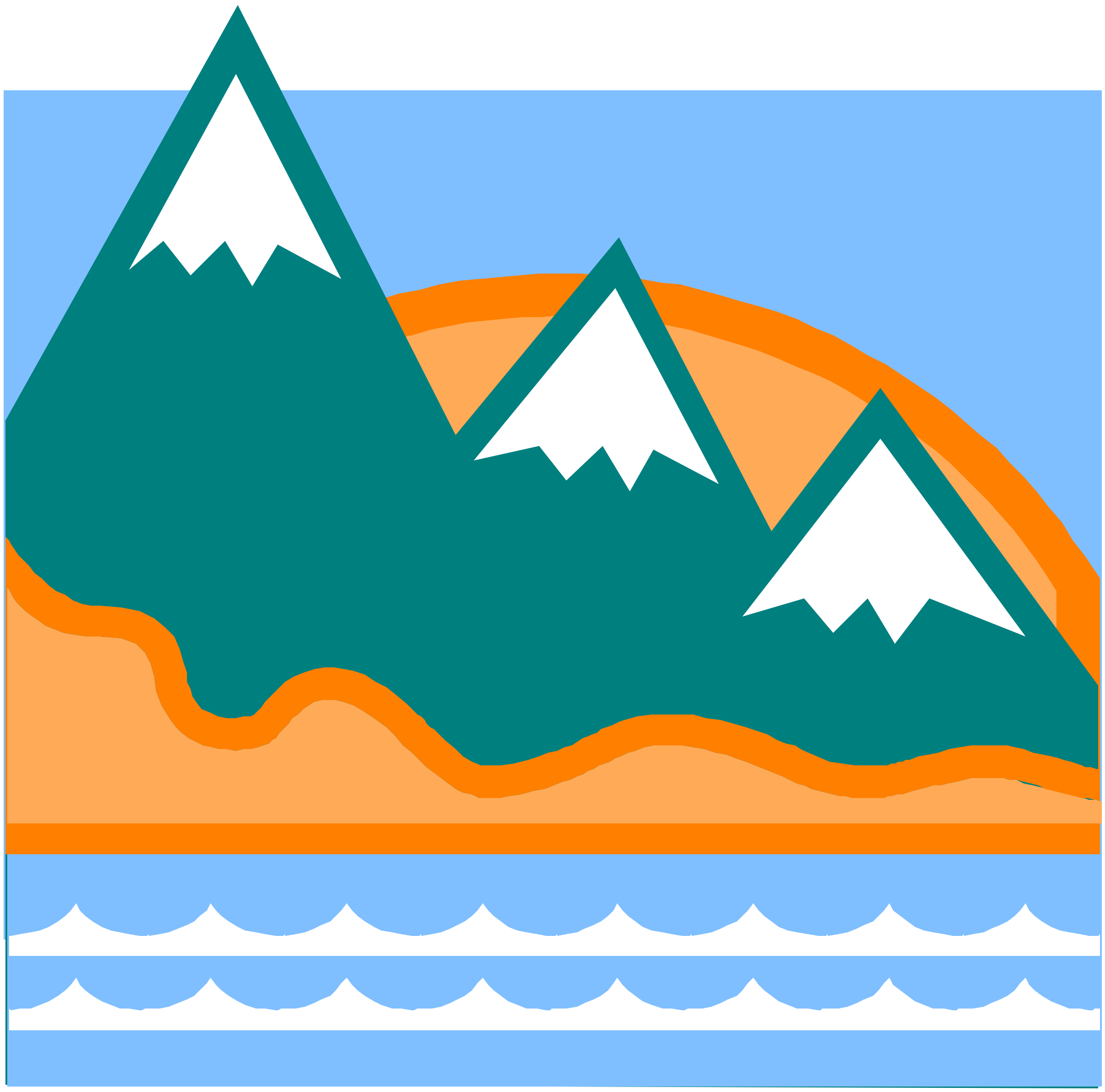
Understanding Natural Amenities:

Impacts on Population and Employment in Missouri



RESEARCH AND PLANNING
Missouri Department of Economic Development

Understanding Natural Amenities:

Impacts on Population and Employment in Missouri

I. Overview

It has been well documented that natural resources are a factor in population and employment change in the United States (Kusmin et al. 1996). However, the nature of this relationship has changed over the past 50 years. Natural resources were once heavily used in extractive industries (i.e. farming, mining, timber, etc.), which drove population and employment change. With the advent of increased technological innovation and environmental regulation, many extractive industries have declined in economic importance (Kusmin 1994). At the same, however, the retirement and recreation sectors of the economy have grown, locating to areas of natural beauty (Beale and Johnson 1998). More recently, information-based industries have grown, allowing many to relocate in high-amenity rural areas (Cromartie and Nord 1996). Given that natural amenities are becoming an increasingly important part of the economic development equation, it is imperative for state agencies to both define and understand this relationship in Missouri.

This report has three main objectives. First, to determine how Missouri counties rate nationally in terms of natural amenity attractiveness. Second, to examine how natural amenities drive population change within Missouri. Third, to examine how natural amenities affect employment change within Missouri. This information is useful in that it allows communities to see to what extent population and employment change is driven by factors beyond local control. Further, it permits communities to assess the role that natural amenities may play in future economic development strategies. For example, some areas possess natural amenities that can be utilized to attract new residents and businesses, whereas other areas do not.

II. Natural Amenities Scale

A. Methodology

For the purposes of this report, an amenity is an attribute that enhances a location as a place of residence. This is distinct from attributes that make a location attractive to tourists, which is usually some unique attraction (historic sites, amusement parks, monuments, etc.) or seasonal venue (skiing, rafting, etc.). Oftentimes, unique places are not necessarily attractive places to live. Further, natural amenities pertain to the physical environment, rather than the cultural or social-economic environment.

Following this line of reasoning, a natural amenities scale was created using six variables that have been frequently used by other researchers (Beale and Johnson

1998; Kusmin 1996; McGranahan 1999). Refer to Appendix A for detailed information and sources. The variables that make up the scale include:

- *Mean January Temperature, 1970-1990.* Based on the assumption that people wish to reside in areas with warm winters.
- *Mean January Sunlight Hours, 1970-1990*. Based on the assumption that people wish to reside in areas with more winter daylight.
- *Mean July Temperature, 1970-1990*. Based on the assumption that people wish to reside in areas that do not experience extreme summer heat.
- *Mean July Humidity Level, 1970-1990*. Based on the assumption that people wish to reside in areas of low summer humidity.
- *Percent Land Area in Water, 1970-1990*. Based on the assumption that people wish to reside in areas with more lakes, rivers and coastlines.
- *Topographic Variation, 1970-1990.* Based on the assumption that people wish to reside in areas where the landscape is hilly or mountainous.

Each variable was standardized to a z-score to remove the effect of different scales. Taking the sum of all six standardized variables then created the natural amenities scale. The amenities scale is highly reliable (α=.81), and is stable across 20 years of data. The scale shows each county's comparative advantage or disadvantage in terms of natural amenities, relative to the United States as a whole. Scores below 0.0 indicate below average amenity attractiveness, relative to the national average. Scores at or near 0.0 indicate that amenity attractiveness is about average, relative to the nation as a whole. Scores above 0.0 indicate above average amenity attractiveness, relative to the national average.

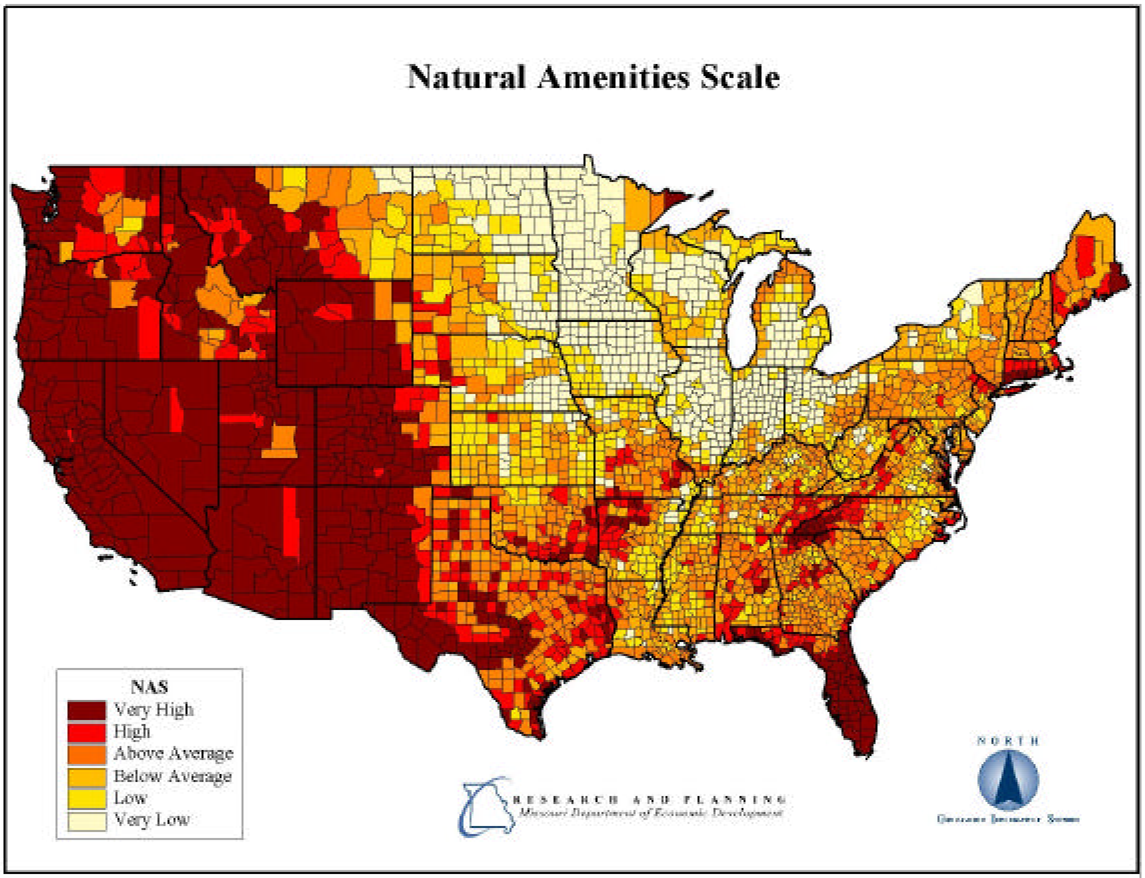
B. National Comparisons

Within the Unites States, high amenities are clustered in seven areas: (1) the Puget Sound area of Washington; (2) the Pacific coast and Cascade Range in Oregon; (3) almost the entire state of California; (4) the Grand Canyon and Flagstaff areas of Arizona; (5) the Jackson Hole and Yellowstone areas of Wyoming; (6) the Colorado Rockies area; and (7) the southern coast of Florida. These areas are located in coastal or mountainous regions, and have temperate climates. Generally speaking, low amenity areas are located in the Upper Midwest, which has flat topography and extremes of heat and cold during the year. Within the central region of the United States, portions of Arkansas, Missouri and Oklahoma possess amenities higher than the national average. Refer to Map 1.

Map 1

Natural Amenities Scale for United States Counties, National Norm, 1999.

Scores are normalized to the United States mean.



Compared to the national average, Missouri ranks 31st on the desirability of its natural amenities (see Chart 1). Compared to the nine other central Midwest states, Missouri ranks 4th (see Table 1). It is important to note that although Missouri ranks low, the difference in amenity scores is quite small. Compared to the national average, Missouri has a natural amenities score of -0.316, indicating slightly below average amenities. Missouri falls within a band of 13 states whose scores do not differ much from the national average. Since scores are not extreme, they can be considered at the national average. In fact, most counties in Missouri fall either slightly above or below the national average (see Chart 2). For a detailed list of state rankings, refer to Appendix B.

Chart 1
Natural Amenities Scale for the United States, 1999
Scores are normalized to the United States mean.

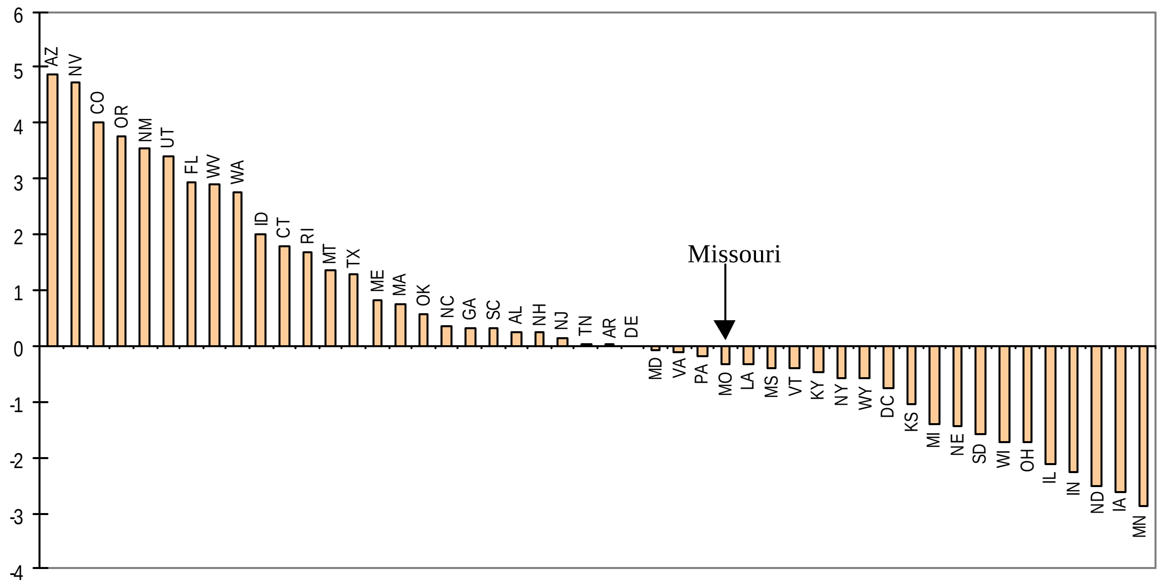
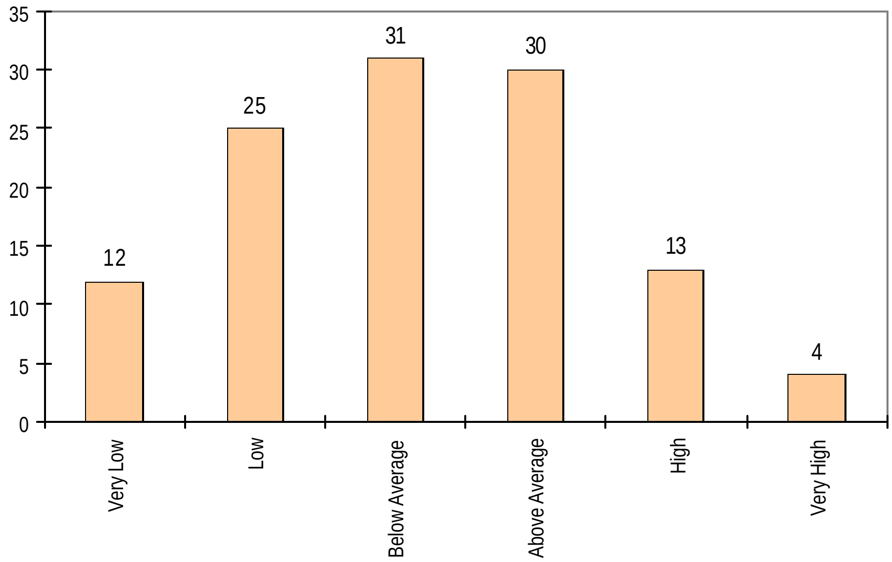


Table 1
Natural Amenities Scale for the Central United States, 1999.
Scores are normalized to the United States mean.

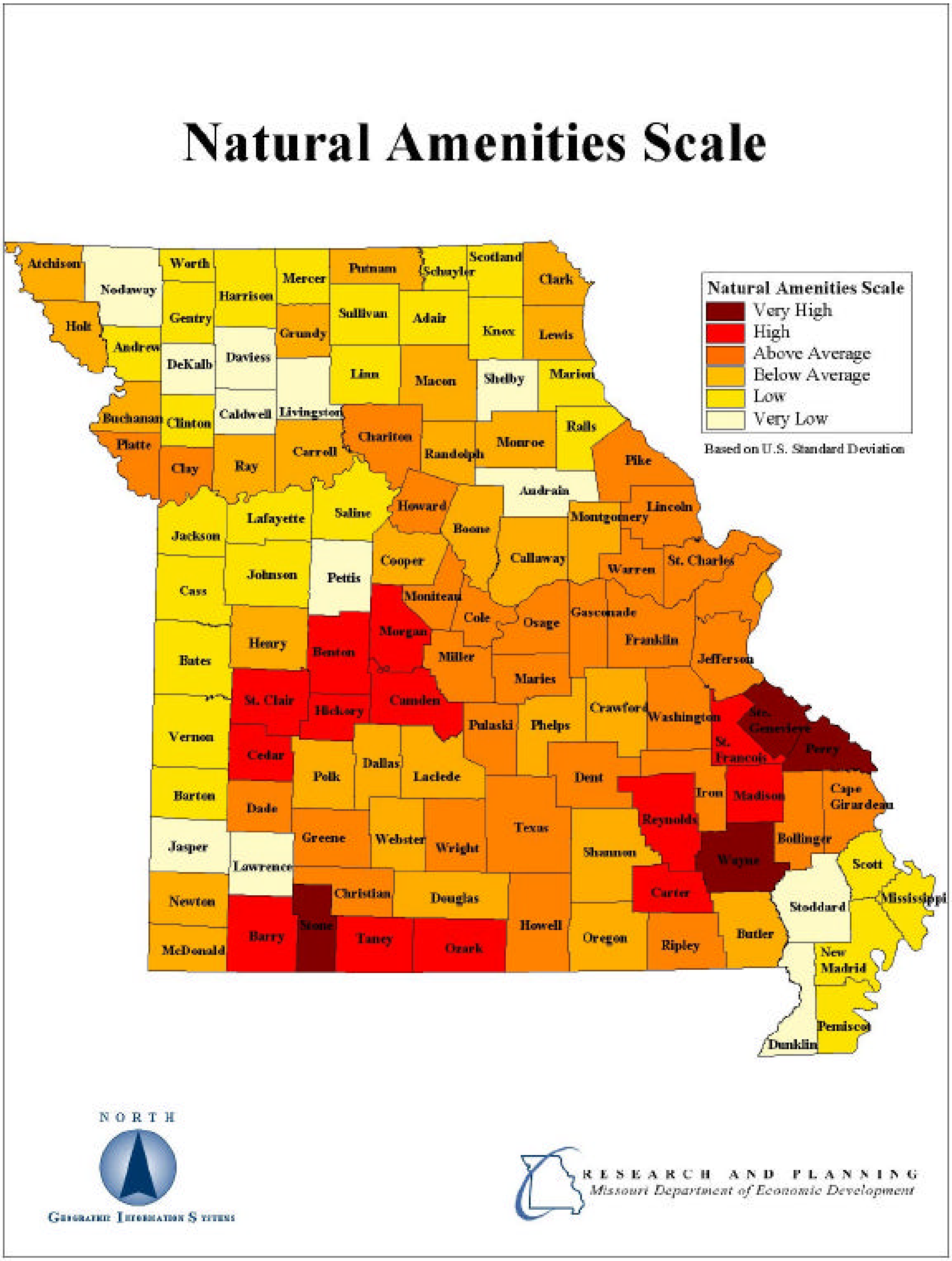
State	*Natural Amenities Score*
Oklahoma	0.586
Tennessee	0.032
Arkansas	0.018
Missouri	-0.316
Kentucky	-0.461
Kansas	-1.041
Nebraska	-1.447
Illinois	-2.122
Iowa	-2.606

Chart 2
Missouri Counties by Natural Amenities Scale, 1999
Scores are normalized to the United States mean.



Additionally, 16 Missouri counties ranked in the top 25% of all counties in the United States on the desirability of its natural amenities. Out of 3,111 counties in the United States, the top Missouri counties are: Perry (416), Stone (427), Wayne (437), Ste. Genevieve (459), Barry (486), St. Francois (546), Camden (549), Taney (565), Ozark (571), Benton (607), Reynolds (632), Cedar (717), Carter (719), Hickory (724), Morgan (725), and St. Clair (771). These counties have the same degree of amenity attractiveness as those found in North Carolina, Idaho, Florida, Colorado and Arkansas. This indicates that several Missouri counties have natural amenities on par with these other states. Nearly all of the top-ranked counties in Missouri are located in the reservoir and national forest regions in the southern part of the state. Key areas are Table Rock Lake, Mark Twain National Forest, Lake of the Ozarks and Truman Reservoir. Refer to Map 2. A list of top-ranked Missouri counties and their national peers can be found in Appendix C.

Map 2
Natural Amenities Scale for Missouri, National Norm, 1999
Scores are normalized to the United States mean.



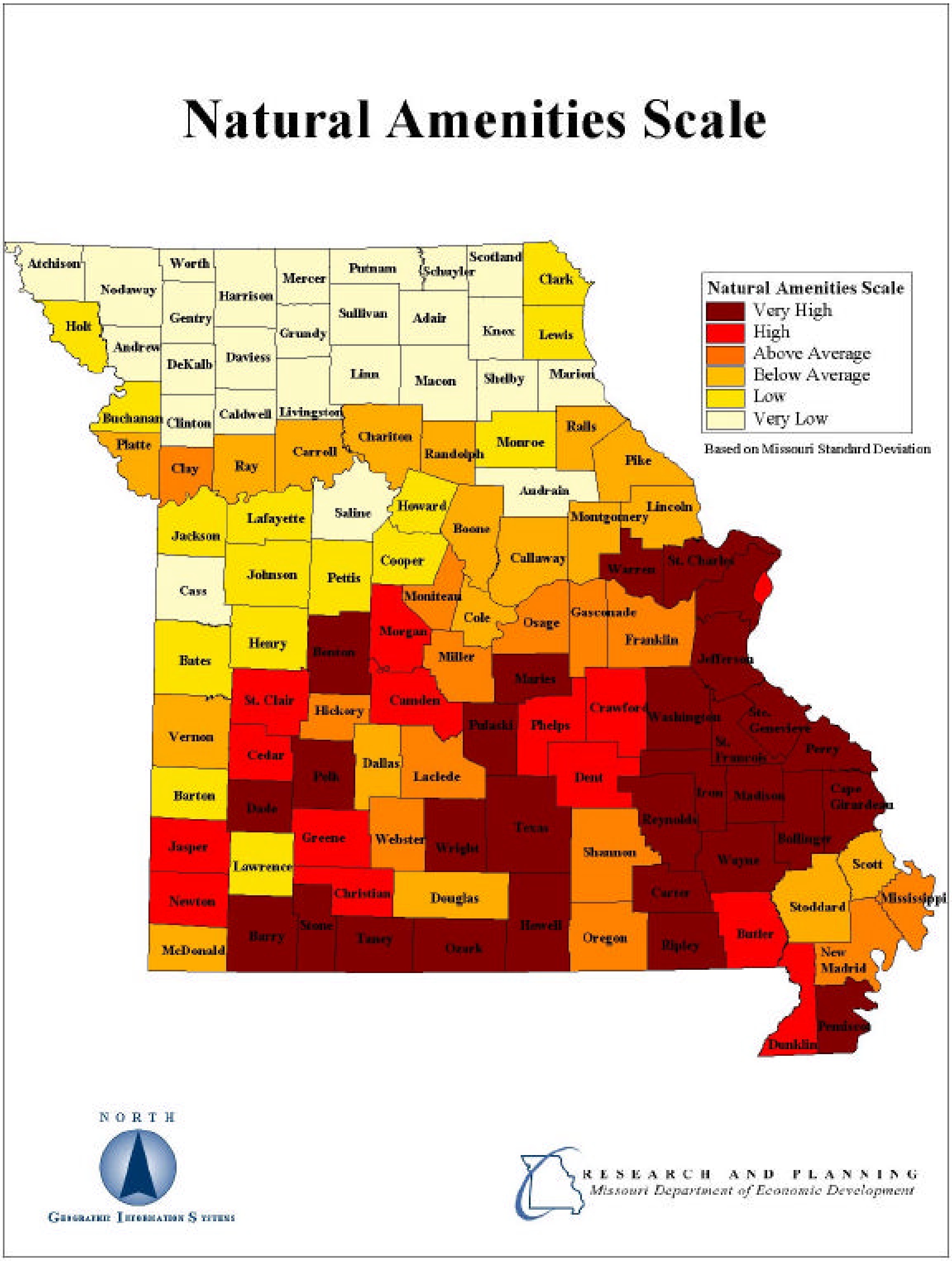
C. Missouri Comparisons

Within Missouri, it appears that high amenity areas are located in the southern portion of the state, which is dominated by varied terrain, public forests and reservoirs. These high amenity areas are centered around Mark Twain National Forest and in the reservoir regions of the state – particularly Truman Reservoir, Table Rock Lake and Wappapello Lake. The counties with the highest amenities are Perry, Stone, Wayne and Ste. Genevieve.

Low amenity areas are located in the northern portion of the state, which is dominated by relatively flat terrain and by intensive agricultural production. The counties with the lowest amenities are Nodaway, Caldwell, Lawrence and Audrain. Interestingly, the area of Mark Twain Lake (Monroe and Ralls counties) posted below average amenity scores for the state as a whole. This is counter to the trend observed in the southern portion of the state. Refer to Map 3.

Another anomaly is Perry County, in the southeast portion of the state. This county is ranked 1st in Missouri and 416th in the United States on natural amenity attractiveness. However, Perry County has no national or state forests, no state parks, and no sizable body of water. The only discernable amenity is the Mississippi River. What makes Perry County highly attractive is its varied topography – numerous river bluffs and rolling hills – which places it well above the national topographic average. This indicates that counties do not necessarily need large tracts of public land or large bodies of water to possess attractive natural amenities. A comprehensive list of natural amenity scores, disaggregated by variable and county, can be found in Appendix D.

Map 3
Natural Amenities Scale for Missouri, State Norm, 1999
Scores are normalized to the Missouri mean.



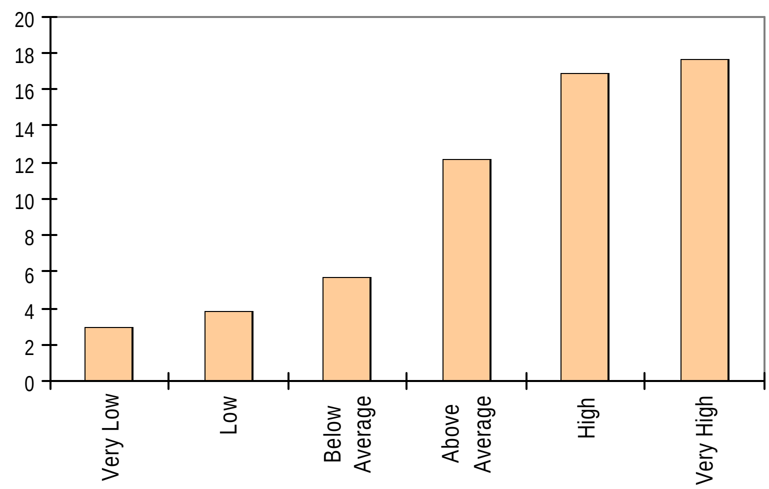
III. Population Change

A. Overview of Change

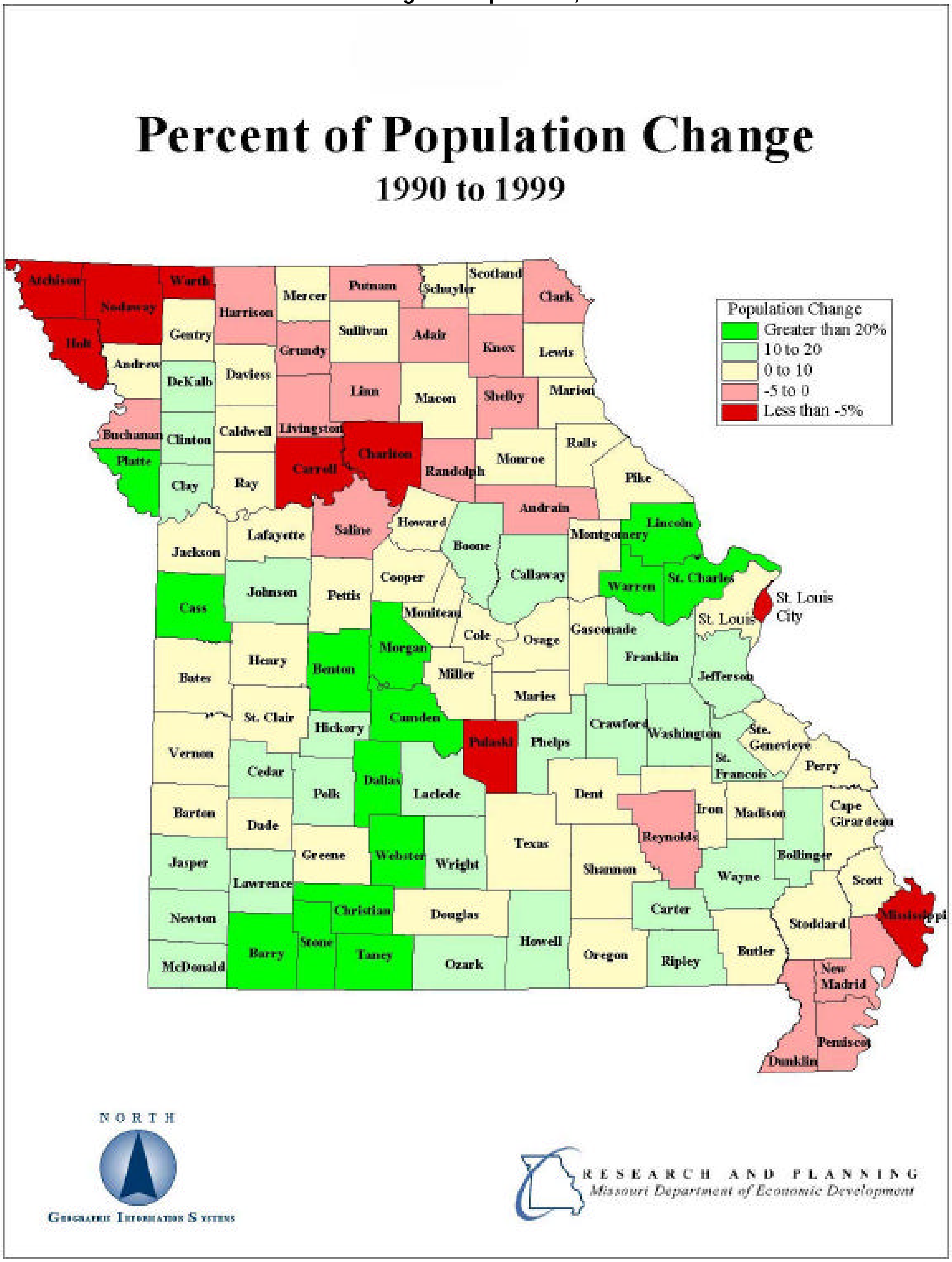
By looking at descriptive statistics, it appears that natural amenities and population change are highly correlated and exhibit a significant positive relationship (r=.87, p=.001). This means that counties with growing populations possessed natural amenities that were higher than average. Conversely, counties with population declines possessed below average natural amenities. This relationship is also shown graphically in Chart 3. Further, when comparing a map of population change (Map 4) with a map of natural amenities (Map 3), it appears that high growth areas are concentrated in high amenity areas; and low growth areas appear to be concentrated in low amenity areas. This seems to indicate that a strong relationship exists between above average natural amenities and population growth.

However, correlation does not imply causation. To more empirically investigate this relationship, we need to determine how population change in Missouri depends upon natural amenities. This can be achieved by employing multiple regression techniques.

Chart 3
Percent Change in Population by Natural Amenities Scale for Missouri, 1990-1999.
Scores are normalized to the Missouri mean.



Map 4
Percent Change in Population, 1990-1999



B. Predicting Change

In order to determine how population change depends upon natural amenities, an Ordinary Least Squares (OLS) regression was used in this analysis. The model attempts to predict change in population given a series of control and predictor variables. The control variables selected are those factors that are most likely to drive population change, as indicated in the economic development literature (Kusmin 1996; Kusmin et al.1994). Although many variables could have been included in the model, only the strongest determinants of population change have been used. Since the model seeks to predict change from 1990 to 1999, all control and predictor variables are from the base year. The City of St. Louis was excluded from the analysis, since it is a small geographic area that is almost entirely urbanized. Refer to Appendix E for additional information regarding the variables used in the model. The model used to predict population change is:

$$Y_i = b_0 + b_1 PSM + b_2 PCI + b_3 EDUC + b_4 PCIEDUC + \pi_5 FARM + \pi_6 MFGR + \pi_7 SERV + b_8 NAS$$

Where:

- Y_i is the change in population between 1990-1999. This is the variable we wish to predict. It is an interval-ratio variable.
- b_1PSM is the population per square mile in 1990. This is a control for urbanization. It is an interval-ratio variable.
- b_2PCI is the per capita income in 1990, and is a control for wealth. To correct for non-normality, the logarithmic term (base10) was computed. It is an interval-ratio variable.
- b_3EDUC is the percent population age 25 and older with a high school diploma or higher in 1990. This is a control for the educational level of the labor force. It is an interval-ratio variable.
- b_4PCIEDUC is the interaction term between per capita income and education, both of which are highly correlated. To correct for multicollinearity, the product of the two variables was computed. It is an interval-ratio variable.
- π_5FARM is a control for counties that are economically dependent (20% or more of jobs and income) on farming in 1990. It is a dichotomous variable.
- π_6MFGR is a control for counties that are economically dependent (30% or more of jobs and income) on manufacturing in 1990. It is a dichotomous variable.
- π_7SERV is a control for counties that are economically dependent (50% or more of jobs and income) on services in 1990. It is a dichotomous variable.
- b_8NAS is the natural amenities scale in 1990. This is a hypothesized predictor of population change. It is an interval-ratio variable.

Econometrics Review
Generally speaking, regression centers on the notion that we wish to predict the value on some variable (known as the endogenous variable) knowing the values of several other variables (known as exogenous variables). Usually, the best guess for predicting a value on the endogenous variable is the mean, but this produces some amount of error due to the inaccuracy of prediction. Regression improves this accuracy by taking into account additional information (control and predictor exogenous variables) in order to more accurately predict values on the endogenous variable.

This model was run on N=114 counties in Missouri, and was highly significant at p=0.001 ($F_{0.0001}(8,105)=5.239$). This indicates that at least one of the exogenous variables contributes significantly in predicting population change. The model explains 23.1% ($R^2_{adjusted}=0.2308$) of the variance in population change between 1990 and 1999. Within the model, the only variables that were statistically significant were NAS and FARM. The natural amenities scale (NAS) exerted a strong positive effect on population change ($b^*=0.4637$), and was highly significant ($p=.0001$). Being a farming dependent county (FARM) exerted a moderate negative effect on population change ($\pi^*=-0.2259$), and was also significant ($p=0.01$). All OLS assumptions were met for the results to be the best linear unbiased estimates. Refer to Table 2.

Table 2
OLS Regression Results – Population Change 1990-1999.

Model Summary	
F(8,105)	5.239
p	0.0001
R^2	0.2853
$R^2_{adjusted}$	0.2308

Variable	Coefficient	Standardized Coefficient	t	p
PSM	-0.00003	-0.1777	-1.498	0.1372
PCI	-0.60031	-0.9748	-1.488	0.1397
EDUC	-0.02978	-5.8958	-1.259	0.2109
PCIEDUC	0.00765	6.8811	1.328	0.1869
FARM	**-0.03043**	**-0.2259**	**-2.536**	**0.0127**
MFGR	-0.00482	-0.0318	-0.365	0.7155
SERV	-0.00272	-0.0259	-0.296	0.7675
NAS	**0.01586**	**0.4637**	**5.281**	**0.0001**

The results of this model indicate that natural amenities is the strongest predictor of population change. The model predicts fairly well, accounting for over 23% of the variance in population change among Missouri counties – much of which can be attributed to natural amenities. It appears that counties with more attractive natural amenities had higher population growth between 1990 and 1999 than lower amenity counties. Further, it appears that counties that are economically dependent on farming had lower population growth than other counties in Missouri. However, this "farm-effect" was only half that of natural amenities. In summary, it appears that natural amenities drove population growth in Missouri between 1990 and 1999. Farm dependency was also a moderate predictor, causing population declines during the same period.

IV. Employment Change

A. Overview of Change

By looking at descriptive statistics, it appears that natural amenities and employment change are only moderately correlated, exhibiting a significant positive relationship ($r=.42$, $p=0.05$). This means that counties with employment growth possessed natural amenities that were higher than average. Conversely, counties with employment declines possessed below average amenities. However, the relationship is not linear. Although increases in employment are associated with more attractive amenities, at the very high amenity end employment gains dropped. Refer to Chart 4. Further, when comparing a map of employment change (Map 5) with a map of natural amenities (Map 3), the correlation between high employment growth and high amenities is tenuous. Although there appears to be some correlation in specific regions, it is not widespread across the state. In general, the relation between employment change and natural amenities is not well pronounced. To more empirically investigate this relationship, we need to determine how employment change in Missouri depends upon natural amenities.

Map 5
Percent Change in Employment, 1990-1999

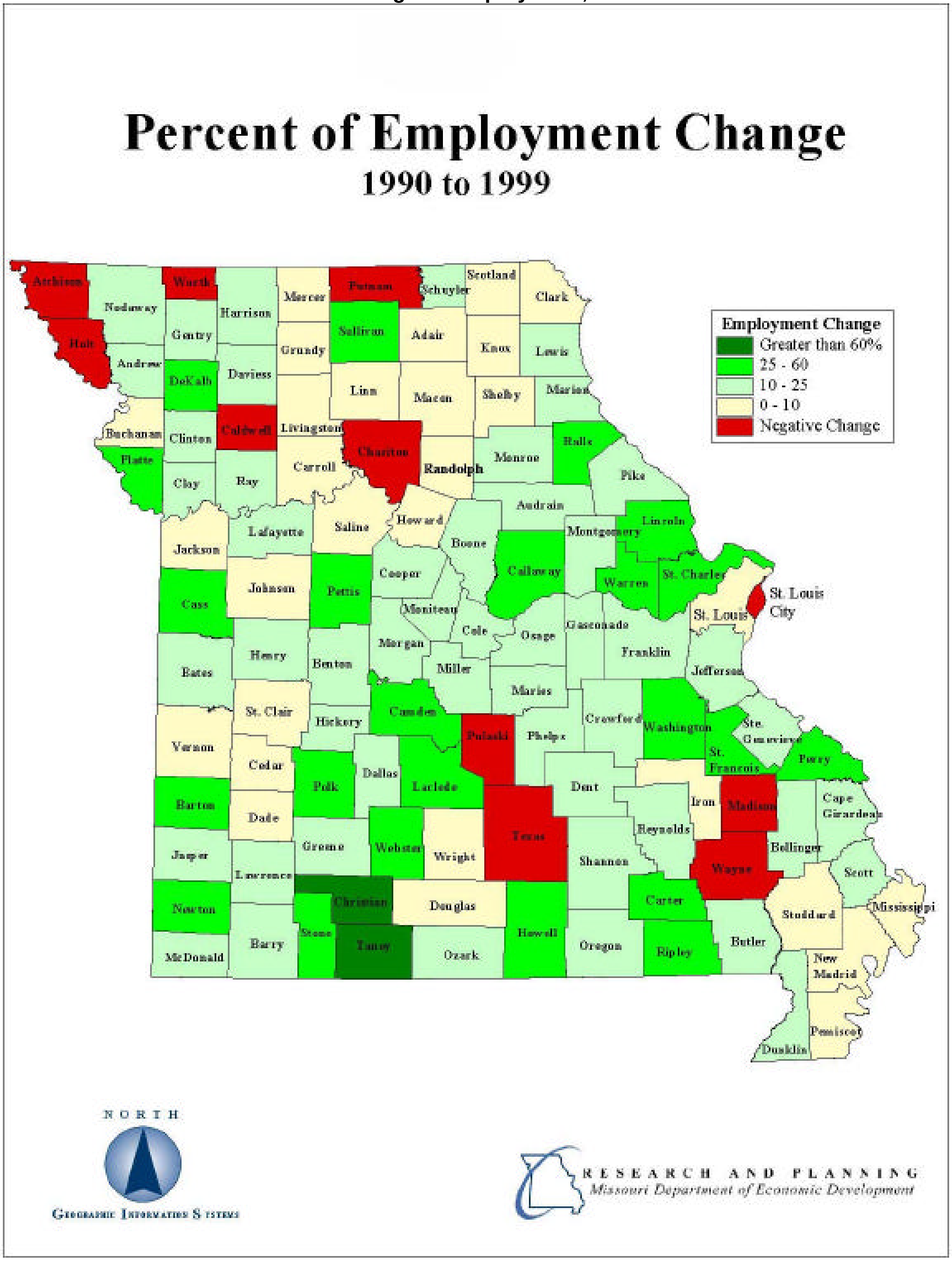
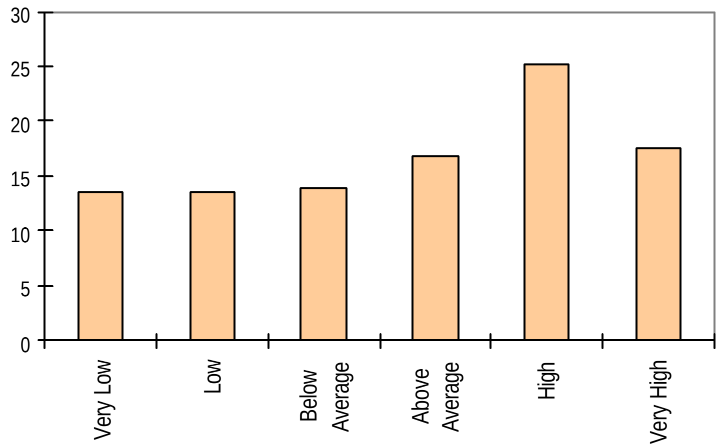


Chart 4
Percent Change in Employment by Natural Amenities Scale for Missouri, 1990-1999.
Scores are normalized to the Missouri mean.



B. Predicting Change

In order to determine how employment change depends upon natural amenities, an Ordinary Least Squares (OLS) regression was used in this analysis. The model attempts to predict change in employment given a series of control and predictor variables. As stated previously, the control variables selected are those factors that are most likely to drive employment change, as indicated in the economic development literature (Kusmin 1996; Kusmin et al.1994). Refer to Appendix E for further model specifications. The model used to predict employment change is:

$$Y_i = b_0 + b_1PSM + b_2PCI + b_3EDUC + b_4PCIEDUC + \pi_5FARM + \pi_6MFGR + \pi_7SERV + b_8NAS$$

Where:

- Y_i is the change in employment between 1990-1999. This is the variable we wish to predict. It is an interval-ratio variable.
- b_1PSM is the population per square mile in 1990. This is a control for urbanization. It is an interval-ratio variable.
- b_2PCI is the per capita income in 1990, and is a control for wealth. To correct for non-normality, the logarithmic term (base10) was computed. It is an interval-ratio variable.
- b_3EDUC is the percent population age 25 and older with a high school diploma or higher in 1990. This is a control for the educational level of the labor force. It is an interval-ratio variable.

- b_4PCIEDUC is the interaction term between per capita income and education, both of which are highly correlated. To correct for multicollinearity, the product of the two variables was computed. It is an interval-ratio variable.
- π_5FARM is a control for counties that are economically dependent (20% or more of jobs and income) on farming in 1990. It is a dichotomous variable.
- π_6MFGR is a control for counties that are economically dependent (30% or more of jobs and income) on manufacturing in 1990. It is a dichotomous variable.
- π_7SERV is a control for counties that are economically dependent (50% or more of jobs and income) on services in 1990. It is a dichotomous variable.
- b_8NAS is the natural amenities scale in 1990. It is a hypothesized predictor of population change. This is an interval-ratio variable.

The model was run on N=114 counties in Missouri, and was statistically significant at p=0.02 ($F_{0.05}(8,105)=2.277$). This indicates that at least one of the exogenous variables contributes significantly in predicting employment change. The model accounts for only a small portion of the variance in employment change between 1990 and 1999, around 8.3% ($R^2_{adjusted}=0.0829$). Within the model, the only significant variables were NAS and FARM. The natural amenities scale (NAS) exerted a moderate positive effect on employment change ($b^*=0.4637$), and was statistically significant ($p=0.03$). Being a farming dependent county (FARM) exerted a moderate negative effect on employment change ($\pi^*=-0.2259$), and was also statistically significant, with reservations ($p=0.058$). All OLS assumptions were met for the results to be the best linear unbiased estimates. Refer to Table 3.

The results of this model indicate that natural amenities and being economically dependent on farming are moderate predictors of employment change – both exerting the same degree of influence. The model predicts only moderately well, accounting for over 8% of the variance in employment between 1990 and 1999. It appears that counties with more attractive natural amenities grew moderately faster in employment than lower amenity counties. Further, it appears that counties economically dependent on farming had slower employment growth than other counties. In summary it appears that both natural amenities and farm dependency influenced employment change between 1990 and 1999. Higher natural amenities caused employment growth, while farm dependency caused employment declines.

Table 3
OLS Regression Results – Employment Change 1990-1999.

Model Summary	
F(8,105)	2.277
p	0.0274
R^2	0.1478
$R^2_{adjusted}$	0.0829

Variable	Coefficient	Standardized Coefficient	T	p
PSM	-0.00004	-0.1872	-1.445	0.1516
PCI	-0.12049	-0.1552	-0.217	0.8286
EDUC	-0.01072	-1.6833	-0.329	0.7427
PCIEDUC	0.00284	2.0319	0.359	0.7201
FARM	**-0.03162**	**-0.1862**	**-1.914**	**0.0583**
MFGR	-0.01911	-0.1002	1.053	0.2948
SERV	-0.02050	-0.1549	1.623	0.1077
NAS	**0.00903**	**0.2093**	**2.184**	**0.0312**

V. Summary

This report addressed three main objectives: (1) how Missouri counties rate nationally in terms of natural amenities; (2) how natural amenities drive population change within Missouri; and (3) how natural amenities affect employment change within Missouri. Based on previous research, a natural amenities scale was created that was methodologically sound and reliable across 20 years. First, compared to the national average Missouri ranks 31st on the desirability of its natural amenities, and 4th compared to nine other Central Midwest states. Although Missouri ranks low, the difference in amenity scores is quite small. This indicates that the state is about average in terms of natural amenities, scoring slightly below the national average. On the county level, Missouri has 16 counties that rank in the top 25% of high amenity areas, out of a total of 3,111 counties nationally. These counties have natural amenities on par with areas in North Carolina, Idaho, Florida, Colorado and Arizona.

In Missouri, high amenity areas are located in the southern half of the state, which is dominated by hilly terrain, public forests and recreational reservoirs. The counties with the highest amenities are Perry, Stone, Wayne and Ste. Genevieve. Low amenity areas are generally located in the northern half and western edge of the state, which is characterized by plains and intensive agricultural production. The counties with the lowest amenities are Nodaway, Cedar, Lawrence and Audrain.

Second, it appears that natural amenities is the strongest predictor of population change between 1990 and 1999. Counties with more attractive natural amenities grew faster in population than lower amenity counties. Further, counties economically dependent on farming grew slower in population than other counties. Taken together, these two factors account for over 23% of the variance in population change between 1990 and 1999. In short, above average natural amenities and an economy *not* dependent on farming seem to be the major determinants of population growth.

Third, it appears that natural amenities is a moderate predictor of employment change between 1990 and 1999. A farm dependent economy is also a moderate predictor of employment change. Counties with above average natural amenities grew somewhat faster in employment than below average counties. Equally significant, an economy dependent on the farm sector led to slower employment growth than other counties. Taken together, these two variables account for only a small portion of the variance in employment change between 1990 and 1999, about 8%. In short, above average natural amenities and a economy *not* dependent on farming are moderate determinants of employment growth.

In conclusion, this report has attempted to delineate the relationship between natural amenities and changes in population and employment. The economy of the 21st century values natural resources not in terms of wealth extracted, but in terms of its natural beauty. This has led to an increase in the recreation and retirement sectors of the economy. Further, information-based firms are locating to areas of high amenities. In Missouri, it is increasingly important to include natural amenities as a factor in any economic development strategy. As a result, an attempt was made in this report to empirically define natural amenity attractiveness at the national level, since no universally accepted measure currently exists.

VI. References

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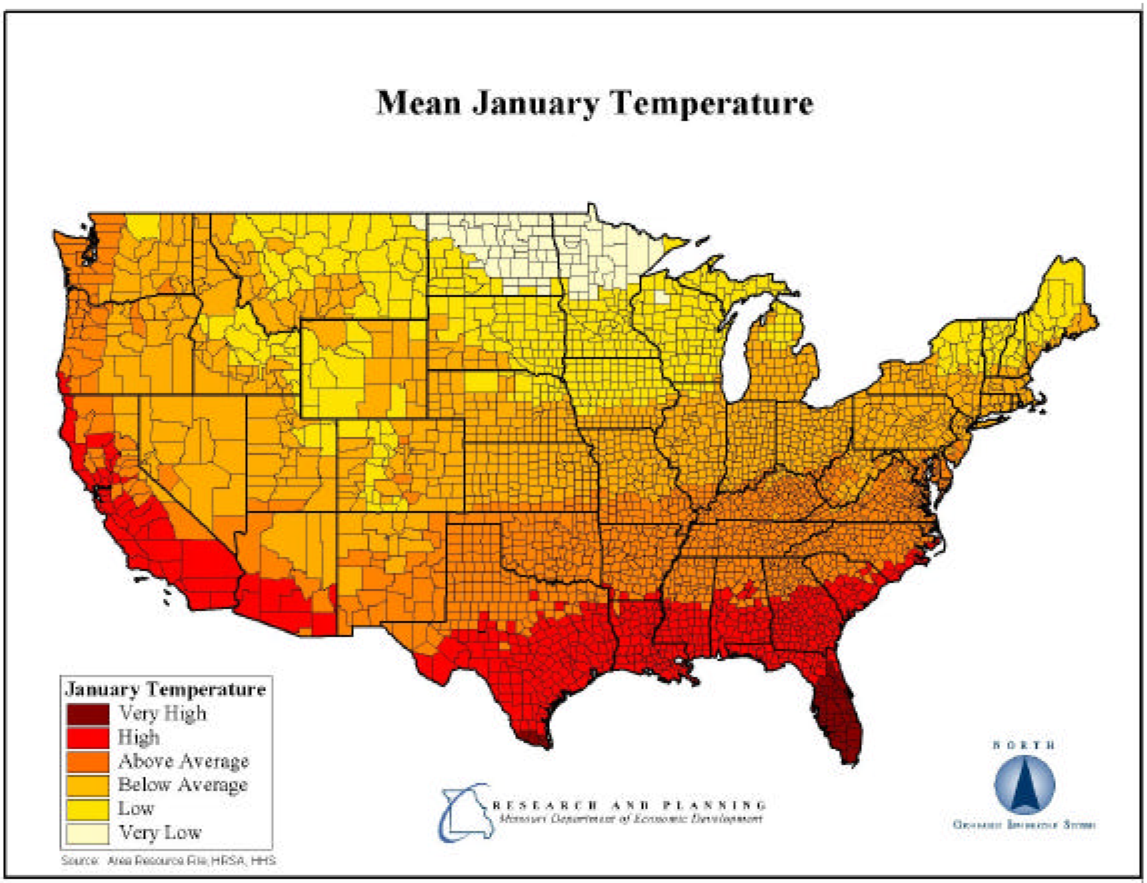
VII. Appendix

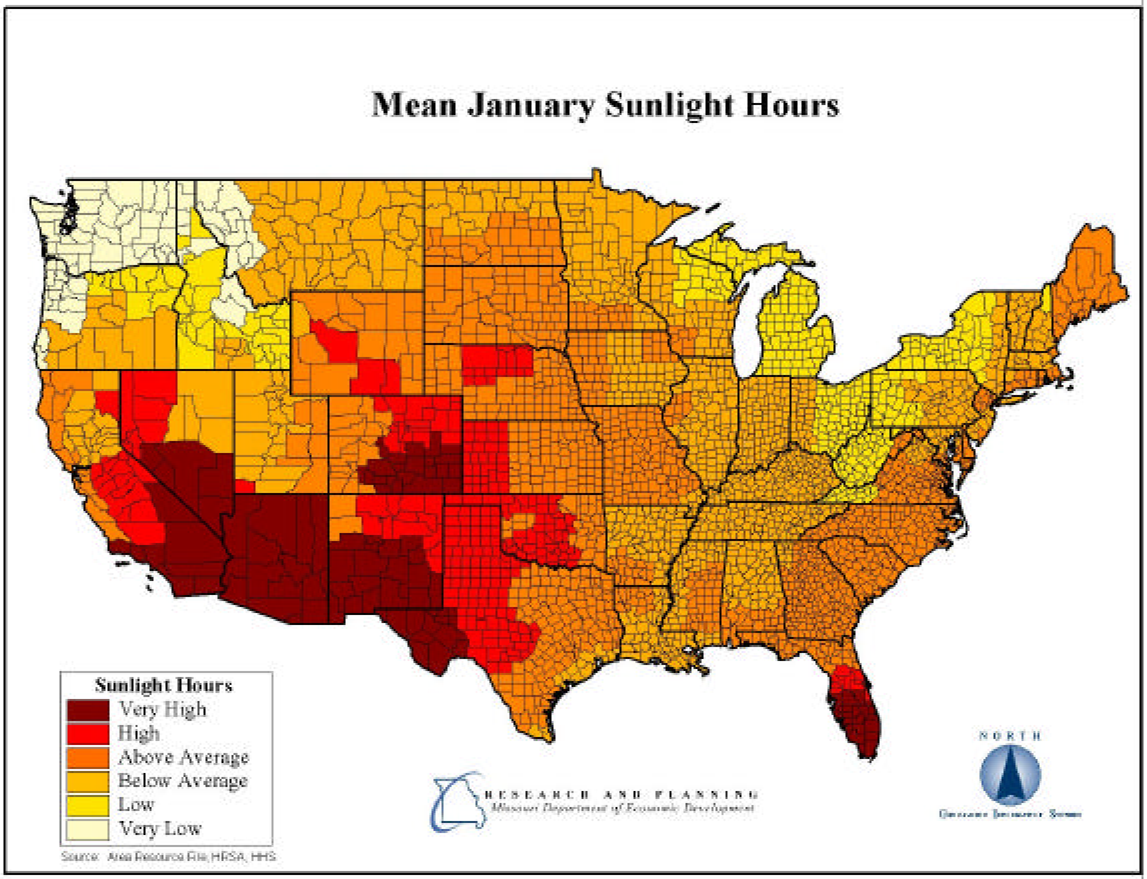
A. Natural Amenities Scale Methodology

The following six measures were used to construct the natural amenities scale. Several other measures were considered, but were dropped for methodological reasons. It was found that *land in forests* had no relationship to population and employment change. *Elevation* was problematic in that it produced results with wide variations when combined with topography (i.e. plains desirable at low elevations, mountains undesirable at high elevations). Other *climatic measures* were dropped because they were highly correlated to other measures used in the analysis. Dropped climatic measures include mean January precipitation, mean January humidity, mean July precipitation, and mean July sunlight hours.

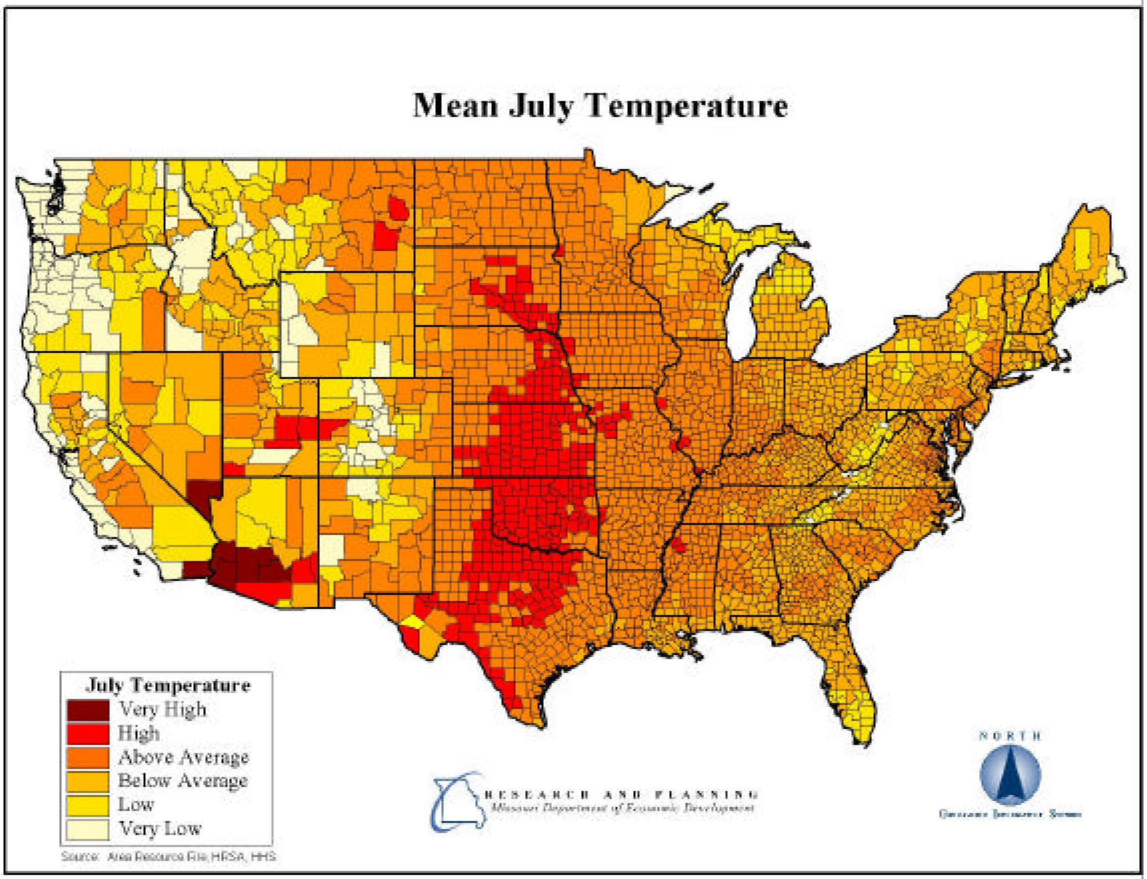
Mean January Temperature, 1970-1990. Based on the assumption that people wish to reside in areas with warm winters. Source: Area Resource File, HRSA, Department of Health and Human Services.



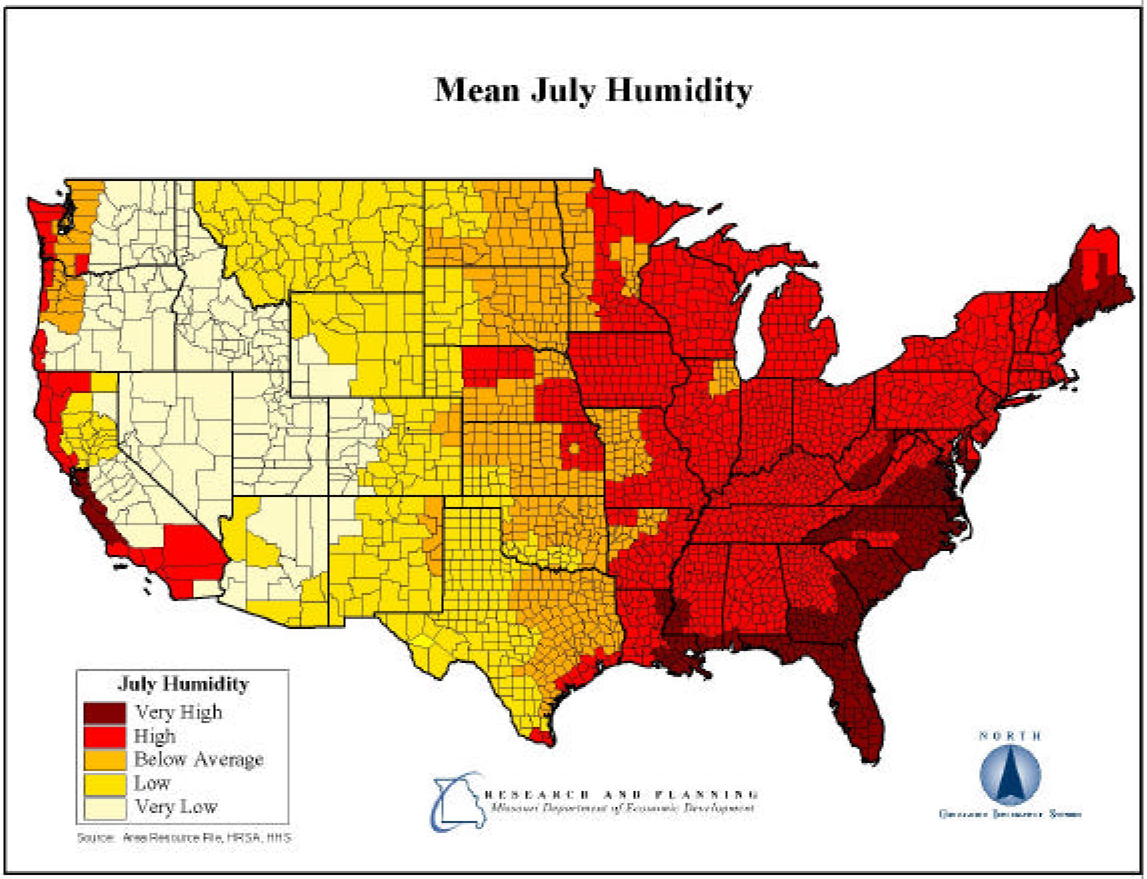
Mean January Sunlight Hours, 1970-1990. Based on the assumption that people wish to reside in areas with more winter daylight. Source: Area Resource File, HRSA, Department of Health and Human Services.



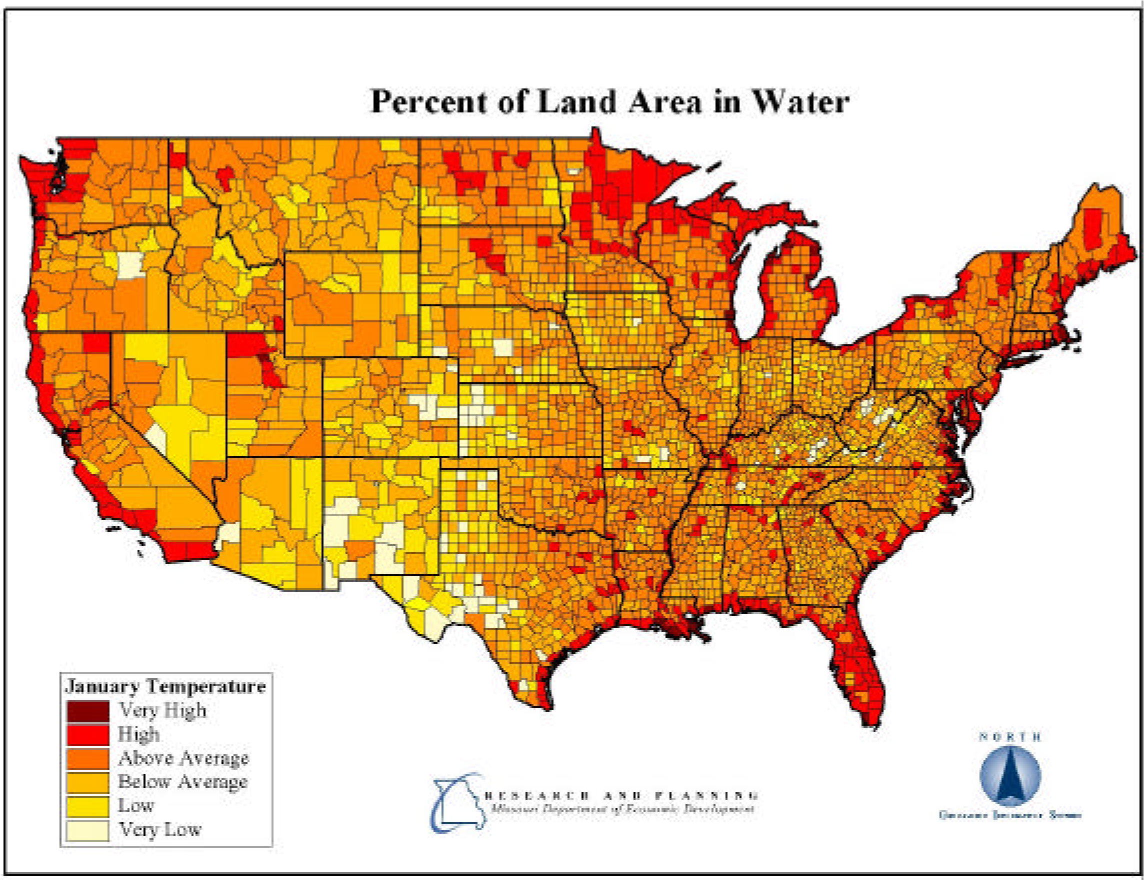
Mean July Temperature, 1970-1990. Based on the assumption that people wish to reside in areas that do not experience extreme summer heat. Source: Area Resource File, HRSA, Department of Health and Human Services.



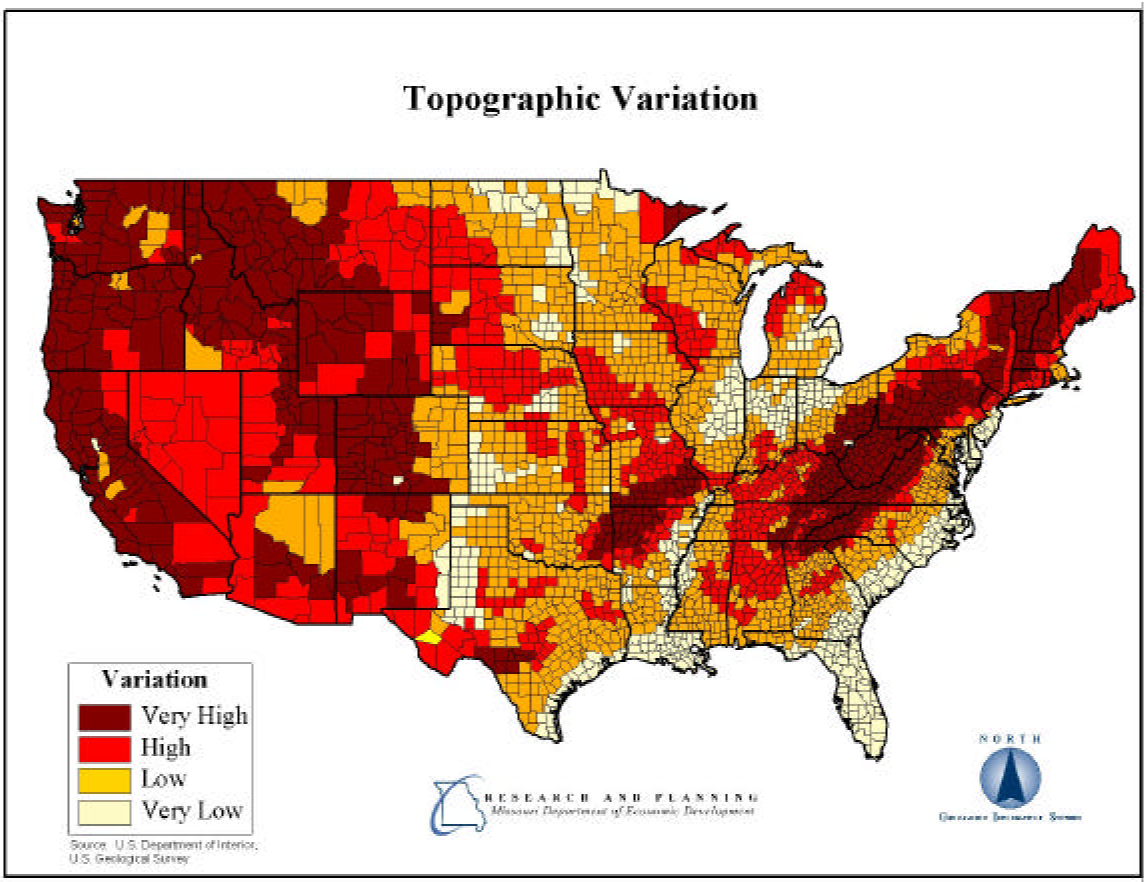
Mean July Humidity Level, 1970-1990. Based on the assumption that people wish to reside in areas of low summer humidity. Source: Area Resource File, HRSA, Department of Health and Human Services.



Percent Land Area in Water, 1970-1990. Based on the assumption that people wish to reside in areas with more lakes, rivers and coastlines. This variable had to be corrected for several major problems. First, coastal counties have boundaries that extend 3 miles out to sea; and counties bordering the Great Lakes include large tracts of water. To remove this distorting effect, each county was limited to a maximum of 250 square miles of water area – thus removing any outliers. Second, to correct for a non-normal distribution the logarithmic term (base 10) for this variable was computed and used in the analysis. Source: ESRI.



Topographic Variation, 1970-1990. Based on the assumption that people wish to reside in areas where the landscape is hilly or mountainous. This variable delineates topography into five broad land formations: plains, tablelands, plains with hills/mountains, open hills/mountains, and hills/mountains. Within each of these broad categories, land was distinguished by its degree of variation. For example, the plains category ranged from “flat plains” to “irregular plains”, and the hills/mountain category ranged from “hills” to “high mountains”. Counties were assigned to one of 21 categories. If more than one category applied to a county, the highest level category was applied, given it covered at least 25% of a county’s area. Source: Department of Interior, U.S. Geologic Survey.



B. Natural Amenities Scale - State Scores

State	Natural Amenity Score
CA	6.7290
AZ	4.8700
NV	4.7176
CO	4.0257
OR	3.7800
NM	3.5361
UT	3.4055
FL	2.9431
WY	2.8826
WA	2.7769
ID	2.0209
CT	1.7963
RI	1.6820
MT	1.3551
TX	1.2729
ME	0.8331
MA	0.7421
OK	0.5861
NC	0.3576
GA	0.3216
SC	0.3159
AL	0.2464
NH	0.2380
NJ	0.1490
TN	0.0320
AR	0.0180
DE	-0.0033
MD	-0.0679
VA	-0.0944
PA	-0.1784
MO	-0.3167
LA	-0.3358
MS	-0.3913
VT	-0.4093
KY	-0.4611
NY	-0.5756
WV	-0.5931
DC	-0.7600
KS	-1.0411
MI	-1.4081
NE	-1.4475

State	Natural Amenity Score
SD	-1.5950
WI	-1.7133
OH	-1.7306
IL	-2.1221
IN	-2.2811
ND	-2.4985
IA	-2.6064
MN	-2.8769

C. Natural Amenity County Rankings - Missouri and U.S. Peers

Missouri County	Rank	Upper County Peer	Lower County Peer
Perry	416	Pope, AR	Comache, OK
Stone	427	Otero, CO	Haywood, NC
Wayne	437	Walton, FL	Buncombe, NC
Ste. Genevieve	459	Knox, ME	Franklin, AR
Barry	486	Washington, FL	Avery, NC
St. Francois	546	Weld, CO	Baylor, TX
Camden	549	Franklin, ID	Malheur, OR
Taney	565	Sabine, LA	Morrill, NE
Ozark	571	Union, FL	Coosa, AL
Benton	607	Yakima, WA	Alleghany, NC
Reynolds	632	Nez Perce, ID	Jefferson, ID
Cedar	717	Rockingham, VA	Surry, NC
Carter	719	Surry, NC	DeKalb, TN
Hickory	724	Habersham, GA	Morgan, MO
Morgan	725	Hickory, MO	Musselshell, MT
St. Clair	771	Red River, LA	Scott Bluff, NE

D. Natural Amenities Scale - Missouri County Scores

COUNTY	Z JANTEMP	Z SUNHRS	Z JULTEMP	Z JULHUMID	Z TOPOG	Z - LOG10 H20AREA	NAS
ADAIR	-0.6420	0.1955	-0.7084	-0.0005	0.6253	-0.5754	-1.11
ANDREW	-0.5841	0.2858	-0.9976	0.2049	0.6253	-0.5465	-1.01
ATCHISON	-0.5841	0.2858	-0.9976	0.2049	0.6253	-0.2993	-0.76
AUDRAIN	-0.4600	0.1955	-0.8416	-0.0005	-1.0430	-0.2824	-2.43
BARRY	0.2349	0.0449	-0.0912	-0.0689	1.5354	0.2998	1.95
BARTON	-0.1126	0.0449	-0.6680	-0.0689	-0.7397	-0.3889	-1.93
BATES	-0.0878	0.2858	-0.8304	0.2049	-0.7397	-0.4835	-1.65
BENTON	-0.0298	0.2858	-0.8239	0.2049	0.7770	1.0561	1.47
BOLLINGER	0.1025	0.5568	-0.3365	-0.0689	1.5354	-1.3029	0.49
BOONE	-0.2946	0.1955	-0.6962	-0.0005	0.7770	-0.0053	-0.02
BUCHANAN	-0.5510	0.2858	-1.2052	0.2049	0.6253	0.1686	-0.47
BUTLER	0.2928	-0.3164	-0.7031	-0.1374	0.7770	-0.7570	-0.84
CALDWELL	-0.5510	0.2858	-0.8287	0.2049	-0.7397	-1.1973	-2.83
CALLAWAY	-0.3607	0.1955	-0.7382	-0.0005	0.7770	0.0674	-0.06
CAMDEN	-0.1374	0.2858	-0.6132	0.2049	0.7770	1.1586	1.68
CAPE GIRARD	0.1439	0.5568	-0.7237	-0.0689	0.7770	0.2289	0.91
CARROLL	-0.3856	0.2858	-1.0060	0.2049	0.6253	0.1395	-0.14
CARTER	0.1935	0.5568	-0.4031	-0.0689	1.5354	-0.5818	1.23
CASS	-0.2367	0.2858	-0.9317	0.2049	-0.7397	-0.2659	-1.68
CEDAR	-0.0878	0.2858	-0.8304	0.2049	0.7770	0.8860	1.24
CHARITON	-0.3856	0.2858	-1.0060	0.2049	0.6253	0.3392	0.06
CHRISTIAN	0.0860	0.0449	-0.6226	-0.0689	1.5354	-0.8908	0.08
CLARK	-0.5345	0.1955	-0.8384	-0.0005	0.6253	0.0289	-0.52
CLAY	-0.4187	0.2858	-1.2287	0.2049	0.6253	0.6862	0.15
CLINTON	-0.5510	0.2858	-0.8287	0.2049	-0.7397	0.1430	-1.49
COLE	-0.1539	0.2858	-0.5766	0.2049	0.7770	0.4241	0.96
COOPER	-0.4021	0.2858	-0.8350	0.2049	0.6253	0.0378	-0.08
CRAWFORD	-0.1208	0.5568	-0.5691	-0.0689	0.7770	-0.8574	-0.28
DADE	0.0777	0.0449	-0.5775	-0.0689	0.7770	0.6944	0.95
DALLAS	0.0446	0.0449	-0.3162	-0.0689	0.7770	-0.6781	-0.20
DAVIESS	-0.5510	0.2858	-0.8287	0.2049	-0.7397	-0.4361	-2.06
DE KALB	-0.4187	0.2858	-1.2287	0.2049	-0.7397	-0.4348	-2.33
DENT	-0.0795	0.5568	-0.3378	-0.0689	1.5354	-0.9992	0.61
DOUGLAS	0.2349	0.0449	-0.2794	-0.0689	1.5354	-2.3510	-0.88
DUNKLIN	0.4252	-0.3164	-0.7266	-0.1374	-0.7397	-0.6019	-2.10
FRANKLIN	-0.0629	0.1955	-0.5088	-0.0005	0.7770	-0.0221	0.38
GASCONADE	-0.0629	0.1955	-0.5088	-0.0005	0.7770	0.0666	0.47
GENTRY	-0.6337	0.2858	-0.8342	0.2049	0.6253	-1.4118	-1.76
GREENE	0.0033	0.0449	-0.5206	-0.0689	1.5354	-0.3757	0.62
GRUNDY	-0.5345	0.2858	-0.8653	0.2049	0.6253	-0.2876	-0.57
HARRISON	-0.6420	0.2858	-0.8428	0.2049	0.6253	-0.8201	-1.19

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COUNTY	Z JANTEMP	Z SUNHRS	Z JULTEMP	Z JULHUMID	Z TOPOG	Z - LOG10 H20AREA	NAS
HENRY	-0.2697	0.2858	-0.7779	0.2049	-0.7397	0.8350	-0.46
HICKORY	-0.1374	0.2858	-0.6132	0.2049	0.7770	0.6997	1.22
HOLT	-0.5841	0.2858	-0.9976	0.2049	0.6253	0.3120	-0.15
HOWARD	-0.3028	0.2858	-0.6241	0.2049	0.6253	0.1005	0.29
HOWELL	0.0777	0.5568	-0.3893	-0.0689	1.5354	-1.3998	0.31
IRON	0.0363	0.5568	-0.2172	-0.0689	1.5354	-1.0297	0.81
JACKSON	-0.4187	0.2858	-1.2287	0.2049	-0.7397	0.4096	-1.49
JASPER	0.1273	0.0449	-0.9560	-0.0689	-0.7397	-0.6651	-2.26
JEFFERSON	-0.0547	0.5568	-1.1455	-0.0689	1.5354	0.1360	0.96
JOHNSON	-0.1291	0.2858	-1.0617	0.2049	-0.7397	-0.5590	-2.00
KNOX	-0.7826	0.1955	-0.7741	-0.0005	0.6253	-0.7366	-1.47
LACLEDE	0.0446	0.0449	-0.3162	-0.0689	0.7770	-0.5897	-0.11
LAFAYETTE	-0.4269	0.2858	-1.3180	0.2049	-0.7397	0.2983	-1.70
LAWRENCE	0.1025	0.0449	-0.4441	-0.0689	-0.5880	-1.5108	-2.46
LEWIS	-0.5345	0.1955	-0.8384	-0.0005	0.6253	0.1566	-0.40
LINCOLN	-0.3277	0.1955	-0.5962	-0.0005	0.7770	0.3188	0.37
LINN	-0.4517	0.2858	-1.1018	0.2049	0.6253	-0.8252	-1.26
LIVINGSTON	-0.5097	0.2858	-0.8932	0.2049	-1.0430	-0.0882	-2.04
MACON	-0.6503	0.1955	-0.8514	-0.0005	0.6253	0.1265	-0.55
MADISON	0.0363	0.5568	-0.2172	-0.0689	1.5354	-0.8365	1.01
MARIES	-0.1208	0.5568	-0.5691	-0.0689	0.7770	-0.3764	0.20
MARION	-0.5179	0.1955	-0.6599	-0.0005	-0.7397	0.2433	-1.48
MC DONALD	0.1273	0.0449	-0.1494	-0.0689	1.5354	-1.6848	-0.20
MERCER	-0.6420	0.2858	-0.8428	0.2049	0.6253	-0.8679	-1.24
MILLER	-0.0133	0.2858	-0.6453	0.2049	0.7770	0.2194	0.83
MISSISSIPPI	0.2018	-0.3164	-0.7172	-0.1374	-1.1947	0.7752	-1.39
MONITEAU	-0.0133	0.2858	-0.6453	0.2049	0.7770	-0.2238	0.39
MONROE	-0.4187	0.1955	-0.7447	-0.0005	-0.7397	0.7672	-0.94
MONTGOMERY	-0.3607	0.1955	-0.7382	-0.0005	0.7770	-0.1840	-0.31
MORGAN	-0.0133	0.2858	-0.6453	0.2049	0.7770	0.6087	1.22
NEW MADRID	0.2018	-0.3164	-0.7172	-0.1374	-1.1947	0.6441	-1.52
NEWTON	0.2597	0.0449	-0.4955	-0.0689	1.5354	-1.6403	-0.36
NODAWAY	-0.8075	0.2858	-0.8000	0.2049	-0.7397	-0.9985	-2.85
OREGON	0.0694	0.5568	-0.1828	-0.0689	0.7770	-1.9162	-0.76
OSAGE	-0.1539	0.1955	-0.5766	-0.0005	0.7770	0.1788	0.42
OZARK	0.2349	0.0449	-0.2794	-0.0689	1.5354	0.1361	1.60
PEMISCOT	0.4252	-0.3164	-0.7266	-0.1374	-1.1947	0.7895	-1.16
PERRY	0.0363	0.5568	-0.2172	-0.0689	1.5354	0.4494	2.29
PETTIS	-0.1126	0.2858	-0.9100	0.2049	-0.7397	-0.7741	-2.05
PHELPS	-0.1208	0.5568	-0.5691	-0.0689	0.7770	-0.7343	-0.16
PIKE	-0.3359	0.1955	-0.5510	-0.0005	0.7770	0.3796	0.46
PLATTE	-0.3442	0.2858	-0.9899	0.2049	0.6253	0.3396	0.12
POLK	0.0777	0.5568	-0.5775	-0.0689	-0.5880	-0.0192	-0.62

COUNTY	Z JANTEMP	Z SUNHRS	Z JULTEMP	Z JULHUMID	Z TOPOG	Z - LOG10 H20AREA	NAS
PULASKI	-0.1208	0.5568	-0.5691	-0.0689	0.7770	-0.0340	0.54
PUTNAM	-0.7661	0.2858	-0.7569	0.2049	0.6253	-0.4925	-0.90
RALLS	-0.3607	0.1955	-0.8995	-0.0005	-0.7397	0.6021	-1.20
RANDOLPH	-0.4187	0.1955	-0.7447	-0.0005	0.6253	0.1267	-0.22
RAY	-0.4269	0.2858	-1.3180	0.2049	0.6253	-0.0898	-0.72
REYNOLDS	0.1935	0.5568	-0.4031	-0.0689	1.5354	-0.4062	1.41
RIPLEY	0.2762	0.5568	-0.5859	-0.0689	0.7770	-0.4717	0.48
SALINE	-0.3028	0.2858	-0.6241	0.2049	-0.7397	0.1753	-1.00
SCHUYLER	-0.7826	0.1955	-0.7741	-0.0005	0.6253	-1.1644	-1.90
SCOTLAND	-0.7826	0.1955	-0.7741	-0.0005	0.6253	-0.8215	-1.56
SCOTT	0.1687	-0.3164	-0.5903	-0.1374	-0.7397	0.1735	-1.44
SHANNON	0.0694	0.5568	-0.1828	-0.0689	1.5354	-2.1385	-0.23
SHELBY	-0.4517	0.1955	-0.7523	-0.0005	-0.7397	-0.5393	-2.29
ST. CHARLES	-0.1457	0.1955	-0.9445	-0.0005	0.7770	0.9802	0.86
ST. CLAIR	-0.0878	0.2858	-0.8304	0.2049	0.7770	0.7639	1.11
ST. FRANCOIS	0.0363	0.5568	-0.2172	-0.0689	1.5354	-0.1433	1.70
ST. LOUIS CO	-0.1291	0.1955	-0.8735	-0.0005	0.7770	0.6730	0.64
ST. LOUIS CI	-0.1291	0.1955	-0.8735	-0.0005	-0.7397	1.0676	-0.48
STE. GENEV	0.0363	0.5568	-0.2172	-0.0689	1.5354	0.2194	2.06
STODDARD	0.2018	-0.3164	-0.7172	-0.1374	-0.7397	-0.7218	-2.43
STONE	0.0860	0.0449	-0.6226	-0.0689	1.5354	1.2689	2.24
SULLIVAN	-0.5345	0.2858	-0.8653	0.2049	0.6253	-1.2939	-1.58
TANEY	0.0860	0.0449	-0.6226	-0.0689	1.5354	0.6566	1.63
TEXAS	0.1273	0.5568	-0.2838	-0.0689	1.5354	-1.4159	0.45
VERNON	0.0198	0.2858	-0.9335	0.2049	-0.7397	-0.4409	-1.60
WARREN	-0.1457	0.1955	-0.9445	-0.0005	0.7770	0.2588	0.14
WASHINGTON	-0.1208	0.5568	-0.5691	-0.0689	1.5354	-0.4728	0.86
WAYNE	0.1935	0.5568	-0.4031	-0.0689	1.5354	0.3631	2.18
WEBSTER	0.0033	0.0449	-0.5206	-0.0689	1.5354	-1.4431	-0.45
WORTH	-0.6337	0.2858	-0.8342	0.2049	0.6253	-1.2107	-1.56
WRIGHT	0.1273	0.5568	-0.2838	-0.0689	1.5354	-0.9922	0.87

Values are reported in standard Z-Scores where: (1) scores of 0.0 are the national mean, (2) scores above 0.0 are standard deviations above the mean, and (3) scores below 0.0 are standard deviations below the mean.

ZJANTEMP - Mean January Temperature.
ZSUNHRS - Mean January Sunlight Hours.
ZJULTEMP - Mean July Temperature.
ZJULHUMID - Mean July Humidity Level.
ZTOPOG - Topographic Variation.
Z-LOG10-H20AREA - Percent Land Area in Water.

E. Econometric Methodology

Generally speaking, regression centers on the notion that we wish to predict the value on some variable (known as the endogenous variable) knowing the values of several other variables (known as exogenous variables). Usually, the best guess for predicting a value on the endogenous variable is the mean, but this produces some amount of error due to the inaccuracy of prediction. Regression improves this accuracy by taking into account additional information (control and predictor exogenous variables) in order to more accurately predict values on the endogenous variable. By doing so, you reduce the amount of error associated with only predicting the mean. Therefore, an Ordinary Least Squares (OLS) regression equation is a mathematical representation of an estimation rule that seeks to minimize the amount of error in prediction. Also, regression deals with the dependence of one variable on other variables, so it does not establish true causation. Regression is a stochastic process in which there is some error in prediction and estimation.

The OLS model used in this analysis is:

$$Y_i = b_0 + b_1 PSM + b_2 PCI + b_3 EDUC + b_4 PCIEDUC + \pi_5 FARM + \pi_6 MFGR + \pi_7 SERV + b_8 NAS$$

Where:

- Y_i is the endogenous variable. Two interval-ratio variables are used in the analysis:
  1. LGPOPCH is the change in population from 1990-1999. To remove the effect of negative numbers, the variable was transformed by taking the LOGe=(100*(T1/T0)) term. To correct for non-normality, the variable was transformed by taking the logarithmic term (base10). Source: U.S. Census Bureau, Population Estimates.
  2. LGEMPCH is the change in employment (all sectors) from 1990-1999. To remove the effect of negative numbers, the variable was transformed by taking the LOGe=(100*(T1/T0)) term. To correct for non-normality, the variable was transformed by taking the logarithmic term (base10). Source: ES-202, Bureau of Labor Statistics.
- b_1PSM is the population per square mile in 1990. This is a control for urbanization. It is an interval-ratio variable. Source: ESRI.
- b_2PCI is the per capita income in 1990, and is a control for wealth. To correct for non-normality, the logarithmic term (base10) was computed. It is an interval-ratio variable. Source: U.S. Bureau of Economic Analysis.
- b_3EDUC is the percent population age 25 and older with a high school diploma or higher in 1990. This is a control for the educational level of the labor force. It is an interval-ratio variable. Source: U.S. Census Bureau.
- b_4PCIEDUC is the interaction term between per capita income and education, both of which are highly correlated. To correct for multicollinearity, the product of the two variables was computed. It is an interval-ratio variable.
- π_5FARM is a farming dependent county in 1990. This is a control for counties that are economically dependent on farming – weighted annual average of 20% or more labor and income from farming between 1987-1989. It is a dichotomous variable. Source: Economic Research Service, U.S. Department of Agriculture.
- π_6MFGR is a manufacturing dependent county in 1990. This is a control for counties that are economically dependent on manufacturing - weighted annual average of 30% or more labor and income from manufacturing between 1987-1989. It is a dichotomous variable. Source: Economic Research Service, U.S. Department of Agriculture.

- π_7SERV is a services dependent county in 1990. This is a control for counties that are economically dependent on services - weighted annual average of 50% or more labor and income from services between 1987-1989. It is a dichotomous variable. Source: Economic Research Service, U.S. Department of Agriculture.
- b_8NAS is the natural amenities scale in 1990. This is a hypothesized predictor of population change. This is an interval-ratio variable. Sources are listed in Appendix A.

The results of this regression are the best linear unbiased estimates, since they meet the key assumptions of OLS regression (for LGPOPCH and LGEMPCH, respectively):

1. *Random Endogenous Variable*: the values of the endogenous variables are produced by chance, and were not chosen a priori.
2. *Normal Endogenous Variable*: both endogenous variables were LOG10 transformed, giving them a normal probability distribution (skewness and kurtosis less than 2.0 on both variables).
3. *Linearity*: plots of each exogenous variable by each endogenous variables showed no curvilinear pattern.
4. *Independent Errors*: the error terms for both OLS models were not correlated, a possible problem with time-series data. The Durbin-Watson statistic was run on both OLS models, and values were around 2.00 indicating no serial correlation (DW=2.248; DW=2.132).
5. *Homoscedasticity*: the variance of the error terms for both OLS models are constant across the full range of exogenous variables. White's test was not significant for both OLS models, indicating that generalized heteroscedasticity is not present ($\_^2$=37.609 p=0.487; and $\_^2$=23.604, p=0.967). Plots of the residuals of the endogenous variables by each exogenous variables revealed normally distributed error terms, indicating that systematic heteroscedasticity is not present.
6. *No Multicollinearity*: no linear relationships were found among the variables. An examination of the correlation matrix indicated no r-value above 0.7.
7. *Model Specified Correctly*: the variables chosen for the model have been validated by other researchers (McGranahan 1999; Beale and Johnson 1998; Kusmin et al. 1996; Kusmin 1994).

Analysis and reporting by David J. Peters, Planner.
Maps by Zachary Johnson, GIS Analyst.

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Direct all correspondence to David J. Peters:
TEL: (573) 522-2791
FAX: (573) 751=7385
E-MAIL: dpeters4@mail.state.mo.us